Wastewater Reuse for Biofuel Production

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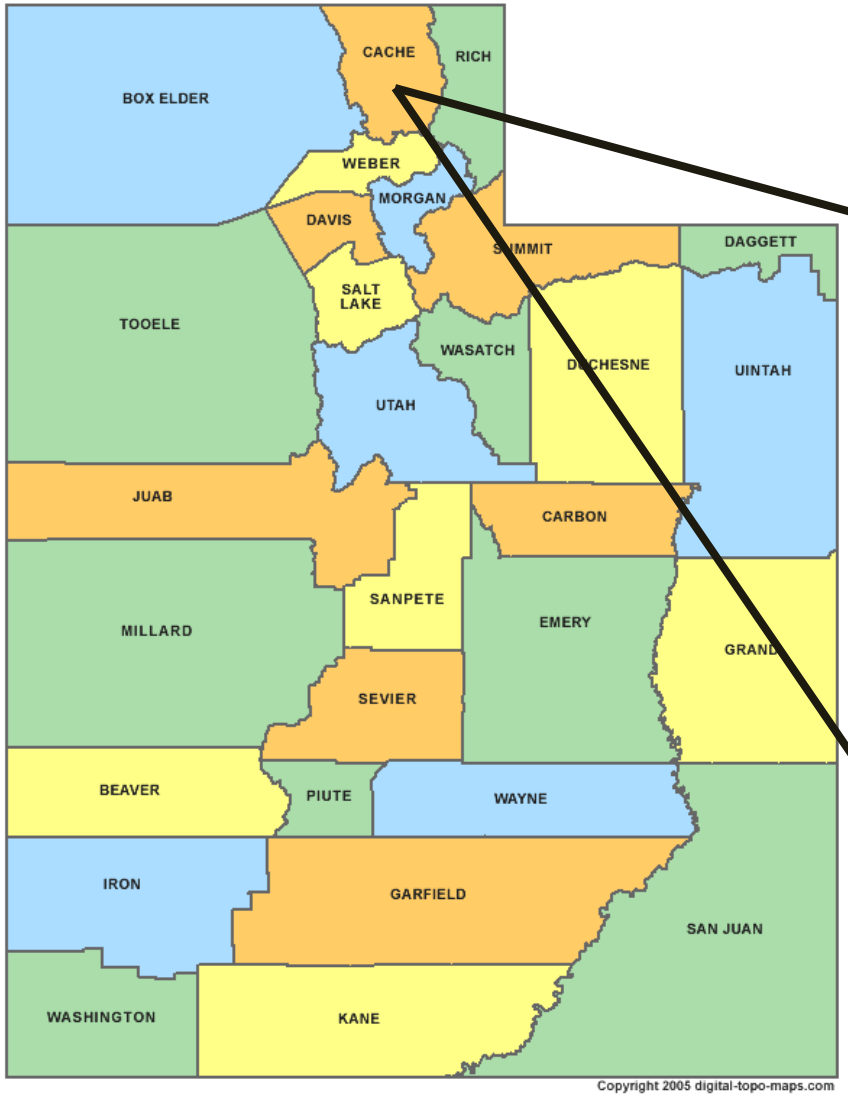
LOGAN CITY UNITED IN SERVICE
ENVIRONMENTAL DEPARTMENT

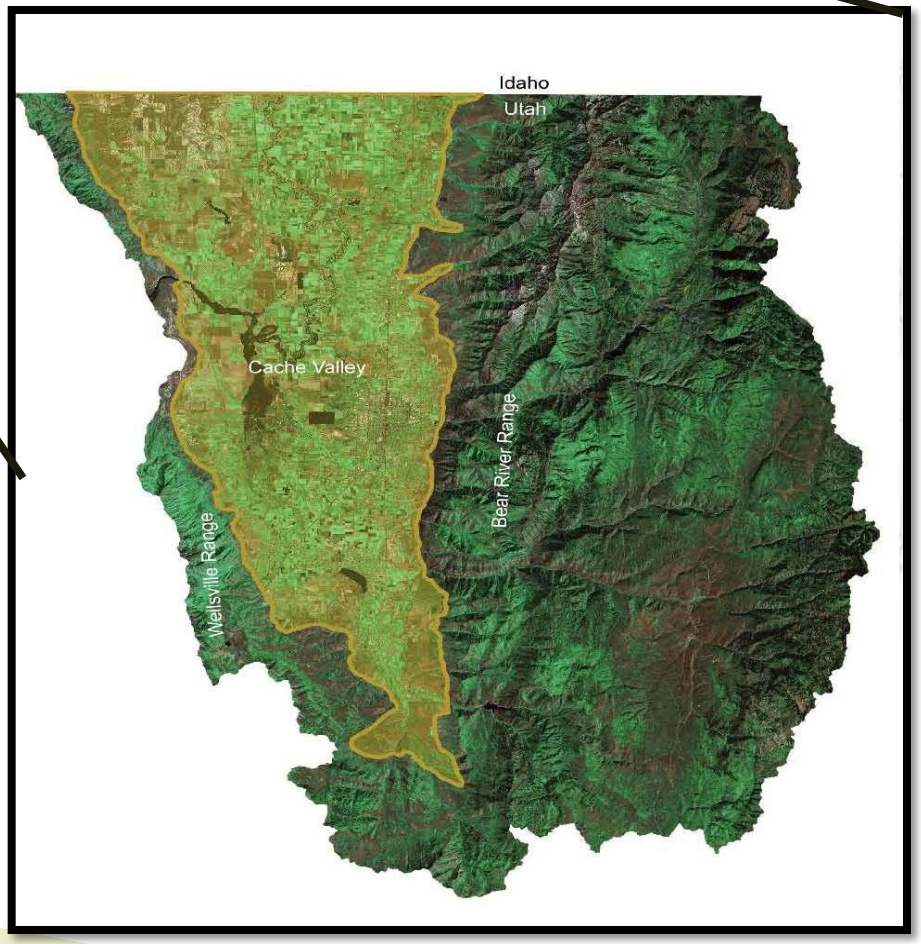
UtahState UNIVERSITY
BIOLOGICAL ENGINEERING

Outline

- The City of Logan Environmental Department
- The Regional Wastewater Treatment Facility
- Wastewater Reuse
- TMDL
- Algae Growth
- Algae Harvesting
- Biofuels

The Place





Cache Valley is the most lovely and enhanced valley I have ever seen, a valley that makes all that has gone before fade as nothing

-Thomas Wolfe

The City of Logan Environmental Department

- Regional wastewater treatment
- County-wide solid waste and disposal

- **Communities Served:**
- Logan
- Smithfield
- Hyde Park
- North Logan
- River Heights
- Providence
- Nibley
- Utah State University

Headworks

- Average Flow: 14 MGD

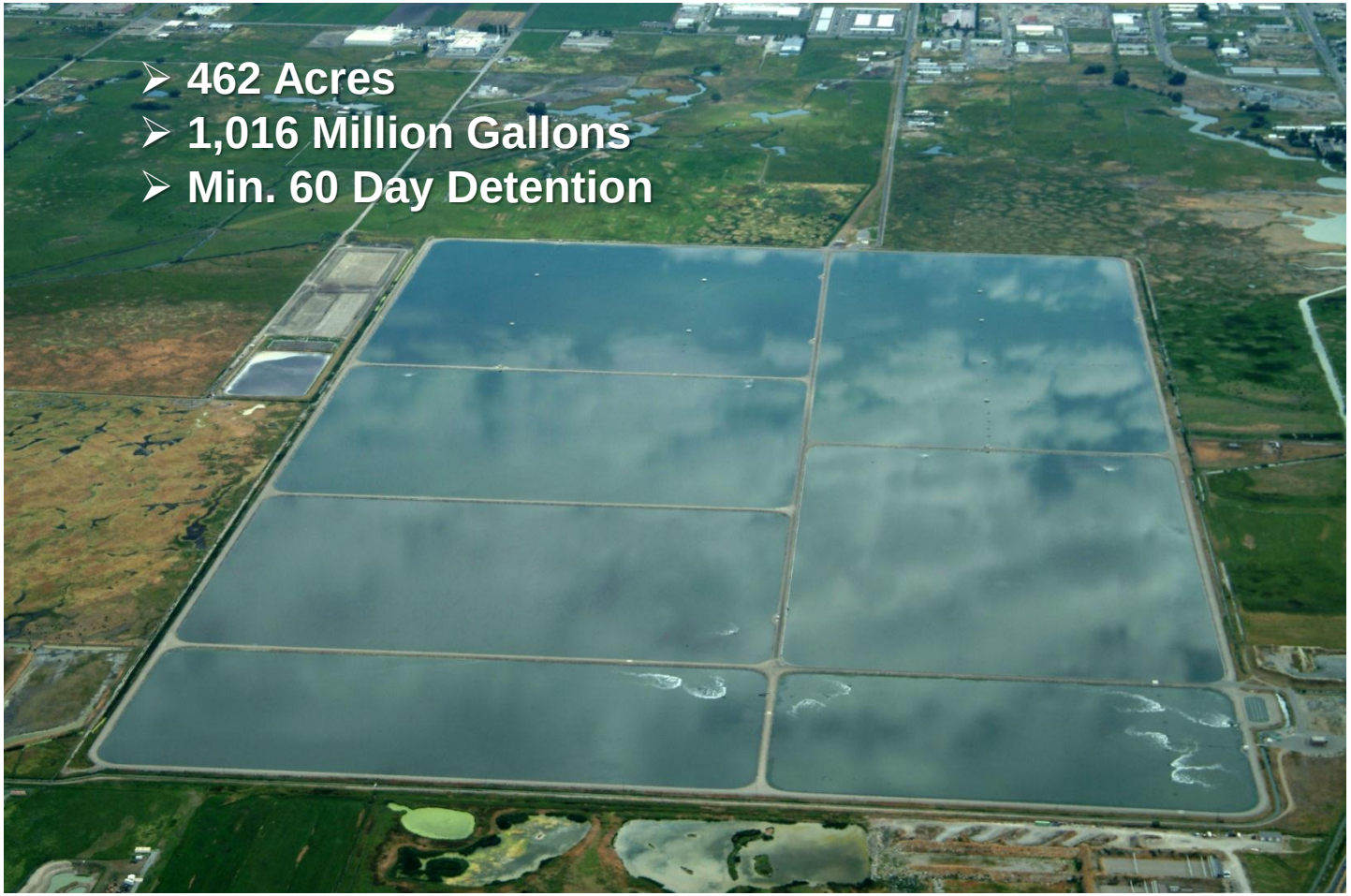
- Bar Screens

Influent Wastewater Characteristics

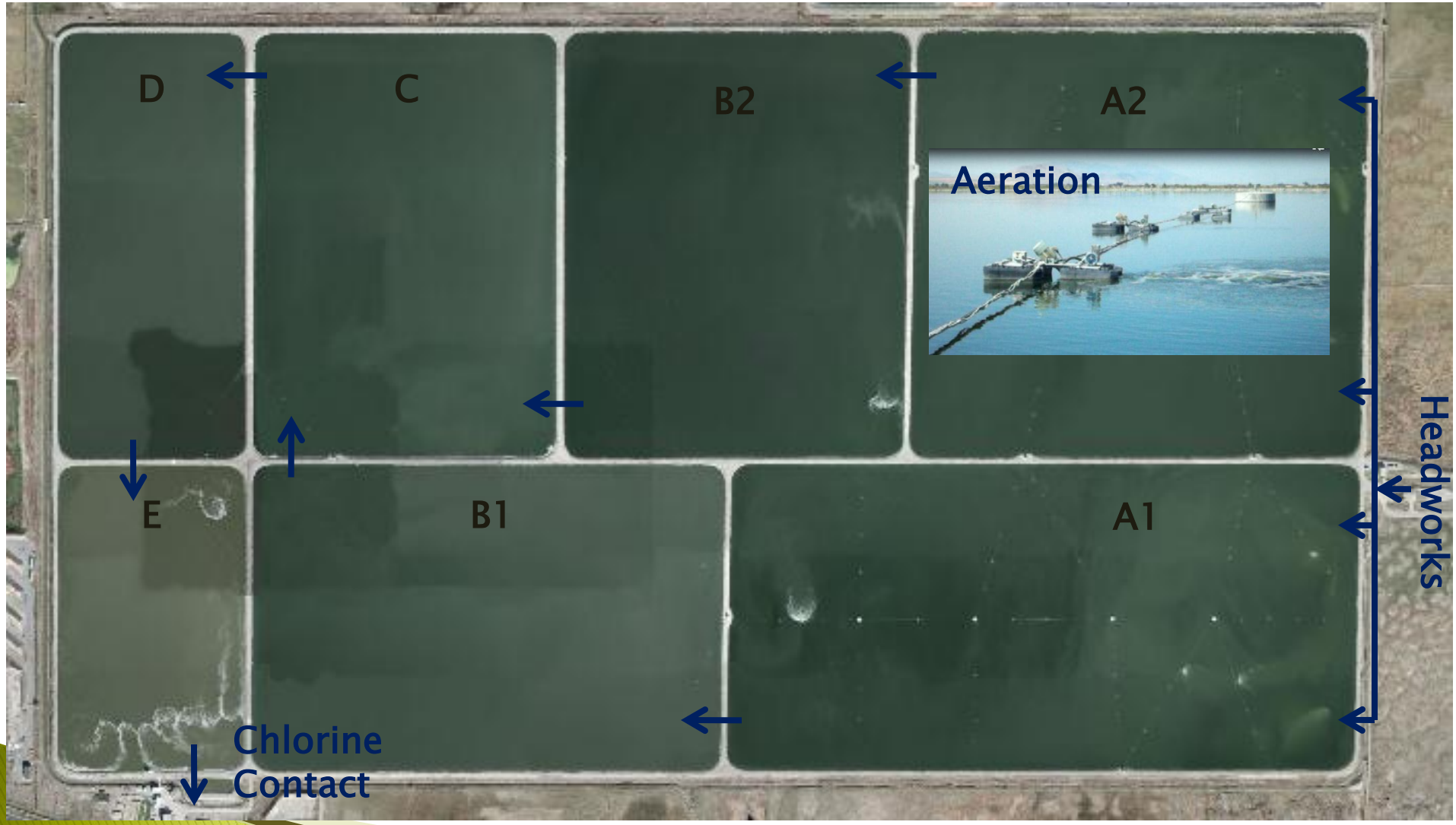
2010 Logan Lagoons Wastewater Influent

Constituent (mg/l)	Spring	Summer	Fall	Winter	Typical Weak Wastewater
TSS	120	87	104	140	100
BOD	108	89	98	118	110
Ammonia	17	14	18	18	12
Total Phosphorus	5	3	4	5	6

City of Logan Wastewater Lagoons



Process Flow



Effluent Water Quality

2010 Logan Lagoons Wastewater Effluent (001)

Constituent (mg/l)	Spring	Summer	Fall	Winter
TSS	22	21	23	40*
BOD	25	9	7	25
Ammonia	14	7	4	11
Total Phosphorus	4	4	2	3

Effluent Limitations

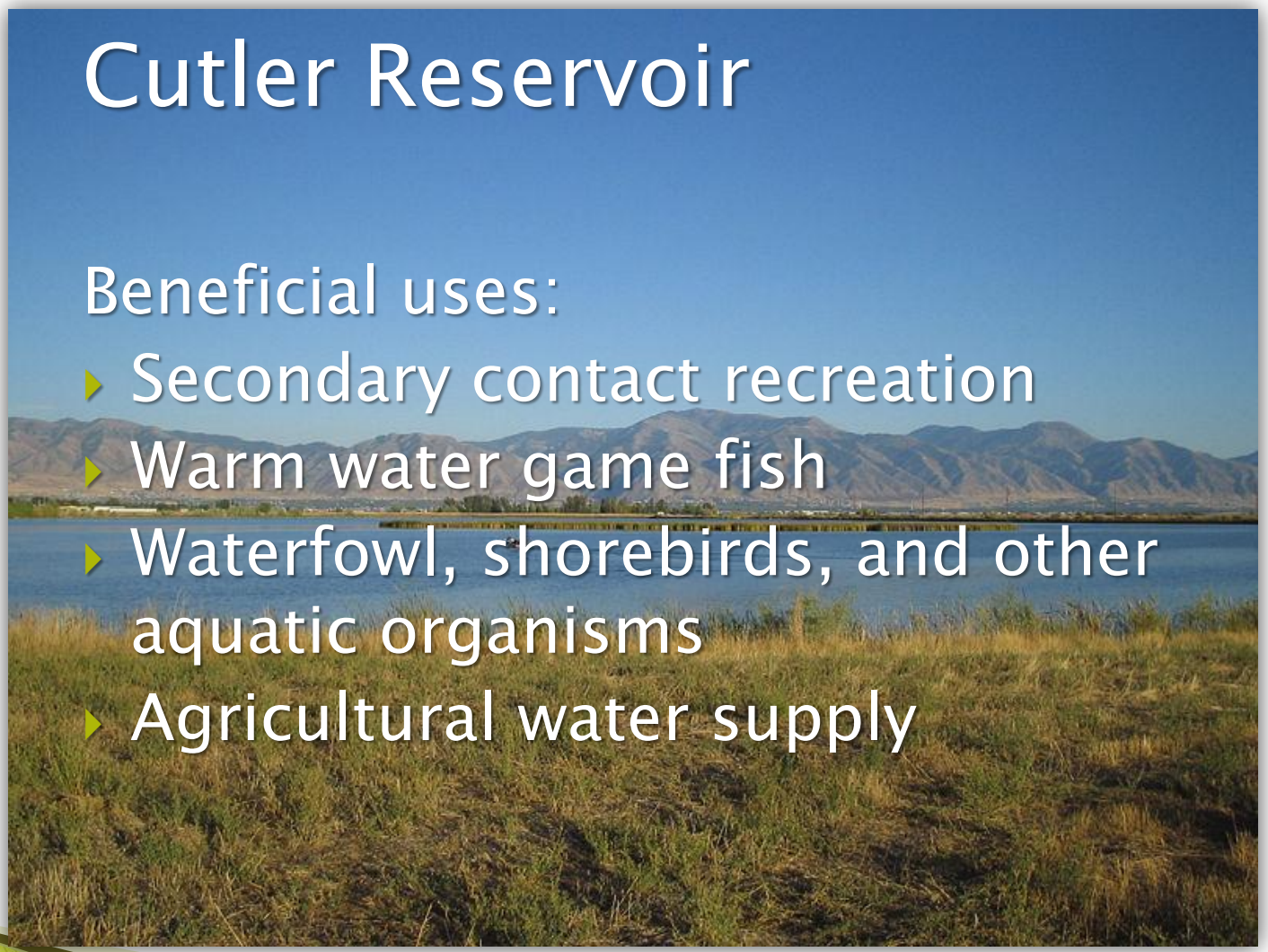
Constituent (mg/l)	30-day Average		7-day Average	
TSS	25		35	
BOD	25		35	
Ammonia	Spring	Summer	Fall	Winter
	11.9	9.1	11.2	14.4

*002 is discharge point in the winter

Current Water Reuse

- Irrigation
  - During the summer months, near 100% of the effluent is used for irrigation by farmers
  - Approximately 800 acres of pastureland and cropland between the WWTP and Cutler Reservoir that are flood irrigated
  - Approximately 580 acres are irrigated fallow/pasture area and 220 acres are used for crop production

Receiving Water Body



City of Logan Constructed Wetlands for Ammonia Reduction

Utah Department of Environmental Quality
Division of Water Quality TMDL Section

Middle Bear River and Cutler Reservoir TMDLs

- TMDL was completed in 2010
- Allowable load of phosphorus:
  - 4,405 kg (May to October)
  - 11, 831 kg (November to April)
- The City will need to reduce the total phosphorus of effluent by as much as 65%

Initial Recommendation for Improvement to Meet New Limits

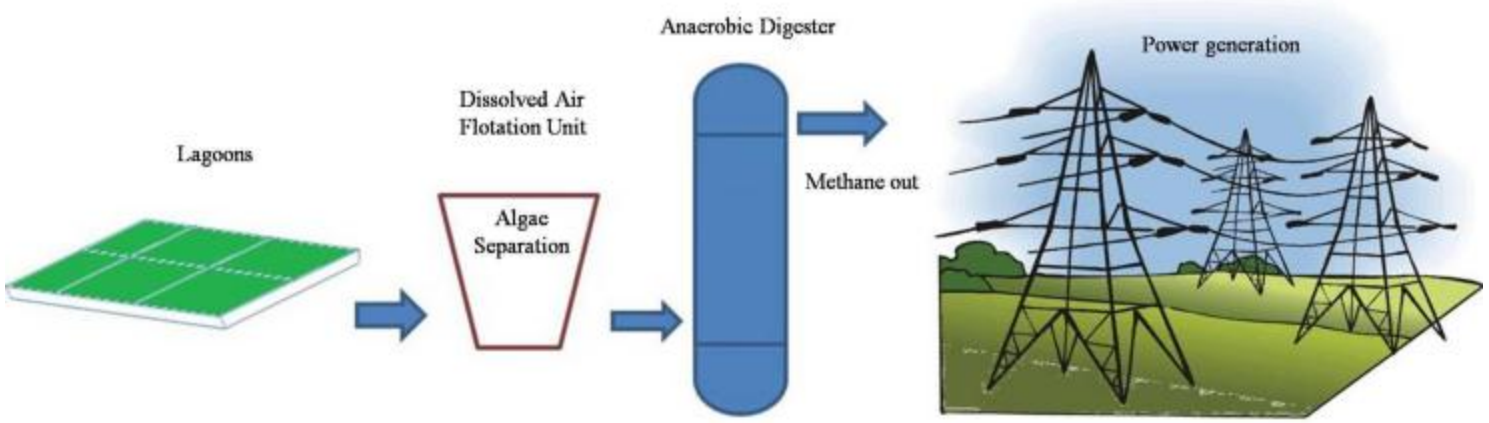
- Sequential Batch Reactor (SBR)

  - Peak Month Average Daily Flow 48 mgd
  - Annual Average Daily Flow 28 mgd
  - Capital Cost $188 million
  - Annual O&M Cost $ 3 million

  - Increasing Logan's base rates $60/month

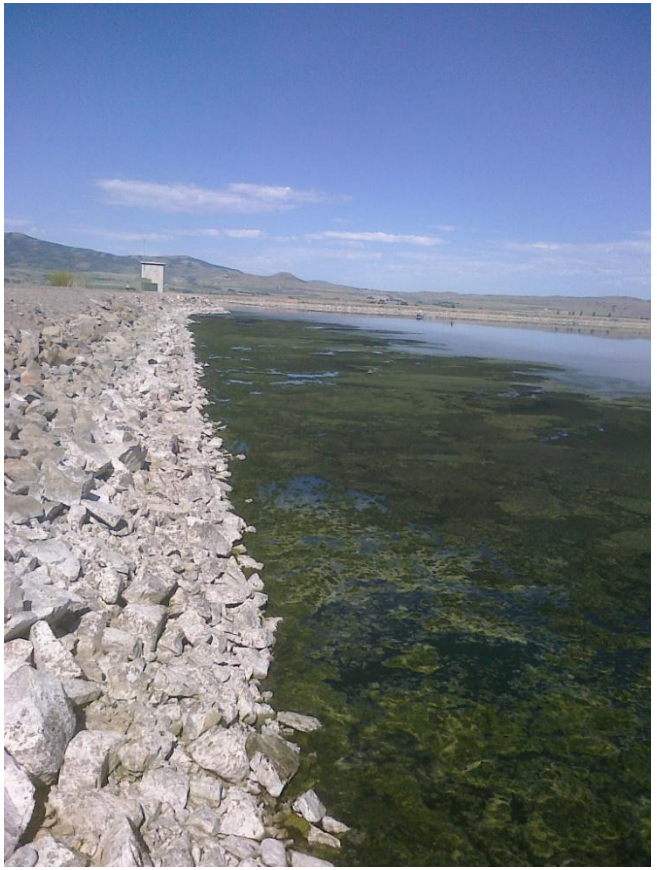
Alternative Solution- Wastewater Reuse for Biofuel Production

- Enhance algae growth to consume nutrients in the wastewater
- Harvest the algae
- Convert algae to biogas

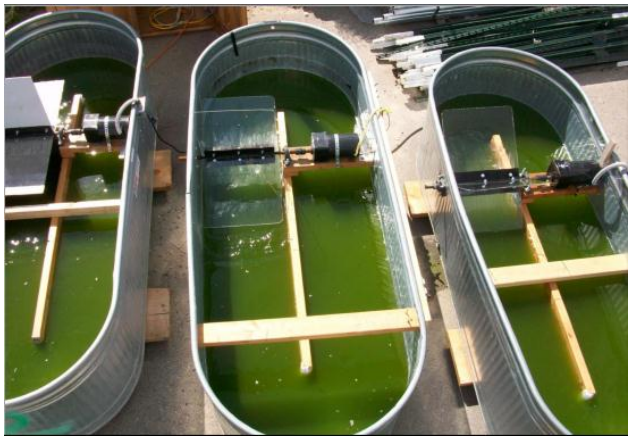


Algae Growth in the Lagoons

- Natural occurring algae growth



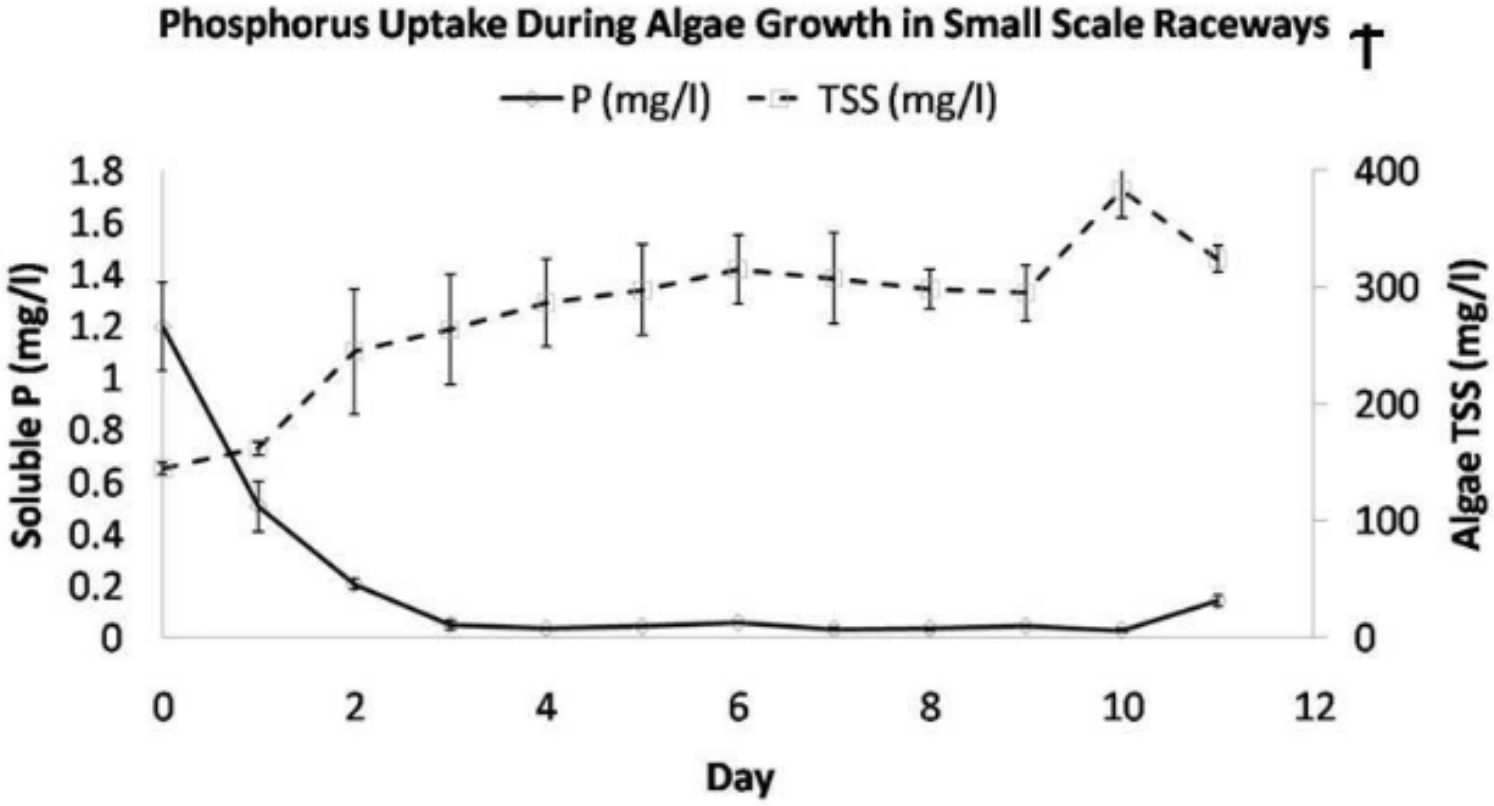
Enhance Algae Growth



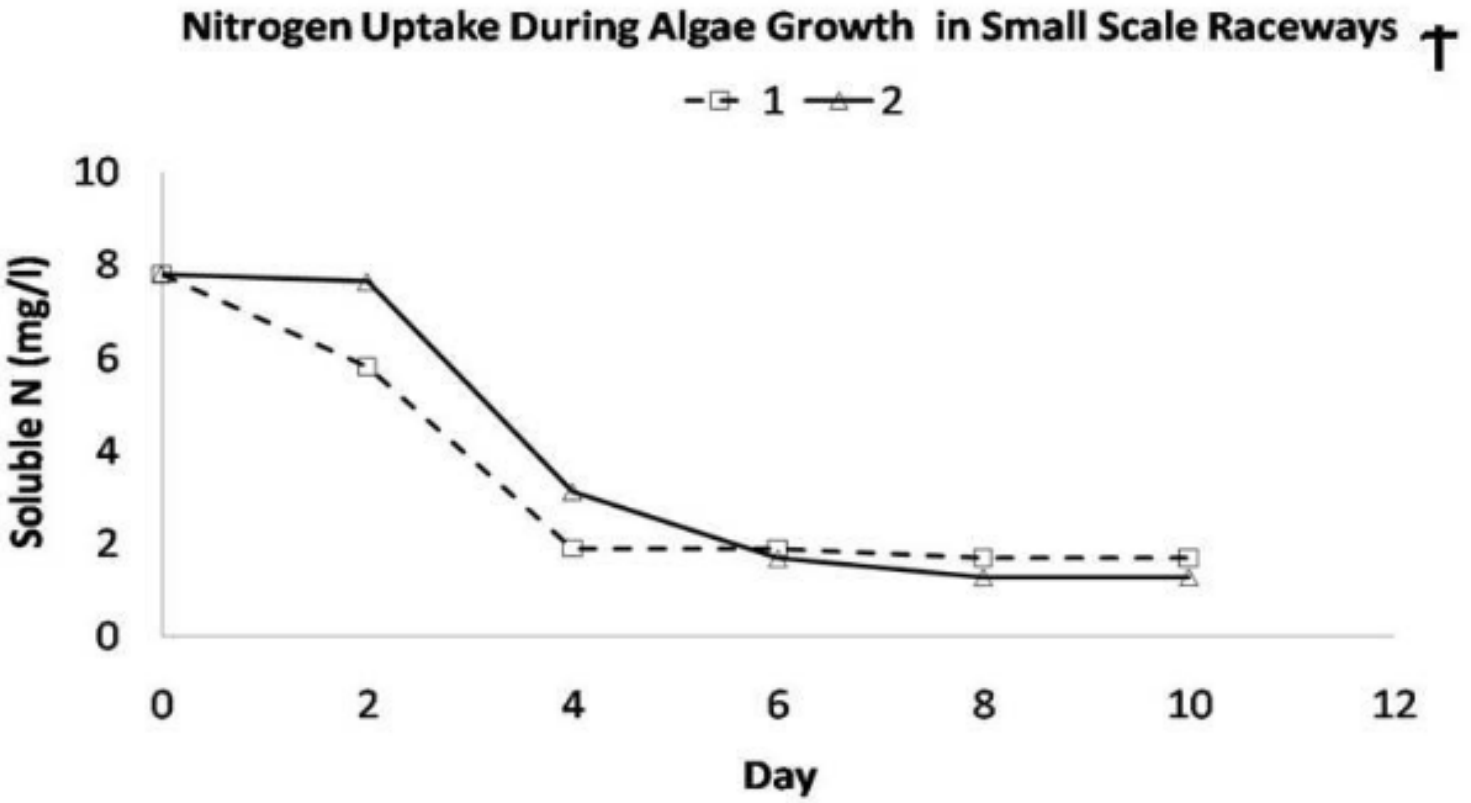
Left: Small Scale Raceways

Right: Pilot Scale Raceways

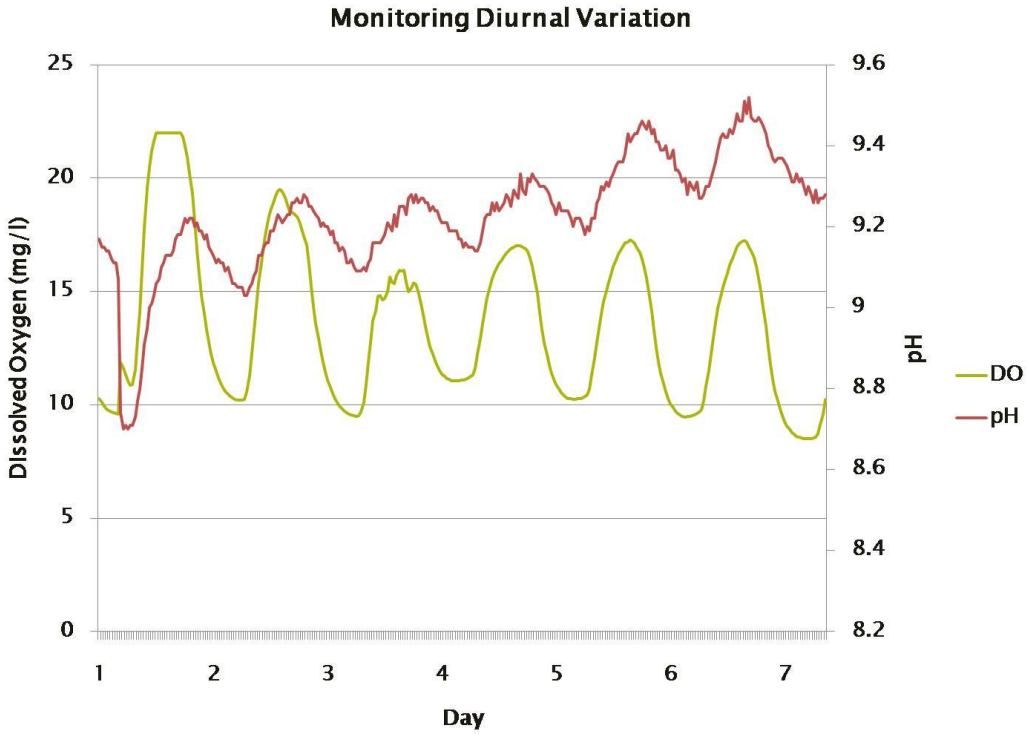
Phosphorus Uptake byAlgae



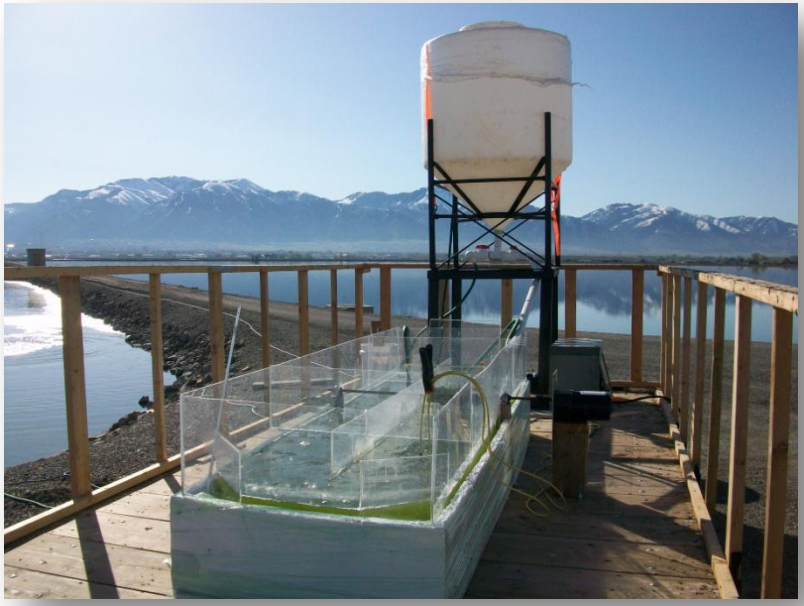
Nitrogen Removal



Enhance Algae Growth

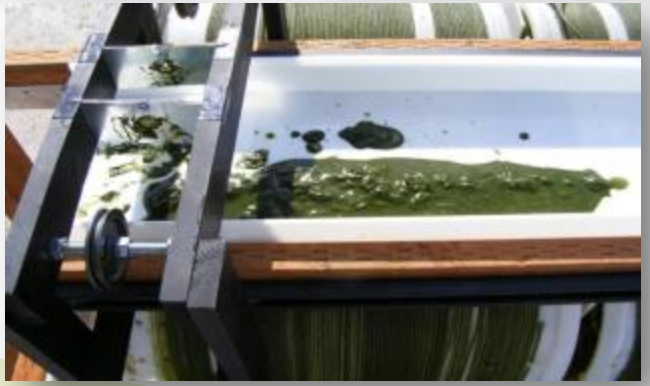


- Mobile Testing Unit



Enhance Algae Growth

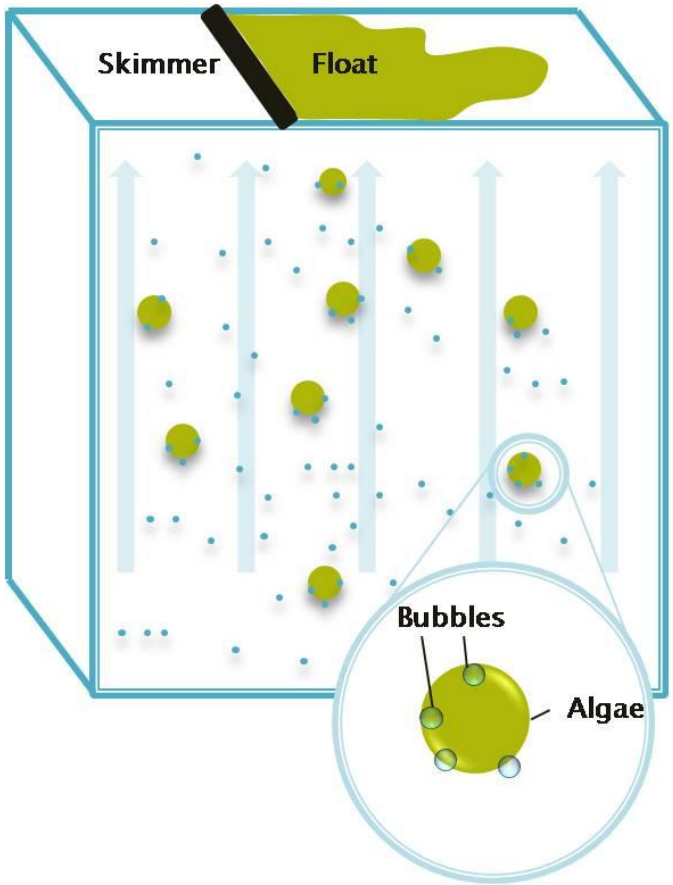
- Rotating Algal Biofilm Reactor (RABR)



Harvesting Algae

- Dissolved Air Flotation (DAF)
- Cross Flow Filtration

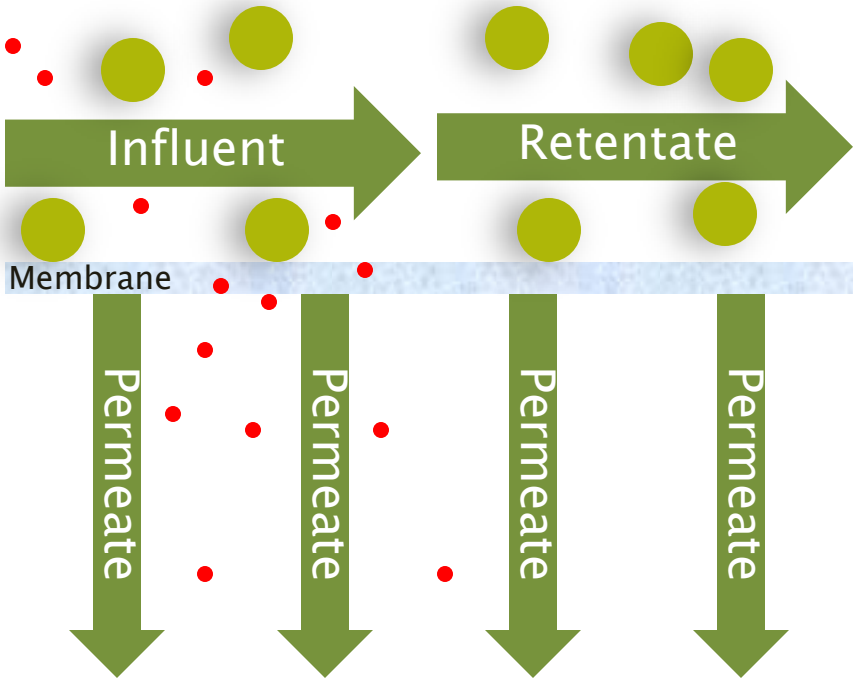
DAF



- Water is supersaturated under pressure
- Pressure is released, micro-bubbles form and raise algae to the surface
- The algae is skimmed off the surface
- Chemicals are added to aid flocculation when necessary

Cross Flow Filtration

- Algal suspension flows parallel to surface of membrane
- Algae contained in the retentate while water is released in permeate



Algae Production Estimates

- Treated Water: 14 MGD
- Average Algae Formula: $C_{106}H_{263}O_{110}N_{16}P$
- Phosphorus Loads: 3-6 mg/l

Estimated Algae Production ≈ 12-24 tons per day (d.w.)

Convert Harvested Algae into Energy

- Biogas
  - Methane combustion to produce electricity
- Biodiesel
  - Run diesel garbage trucks
  - Logan City operates approximately 40 trucks

Pilot Testing to Convert Algae to Biogas

Anaerobic Digesters on-site

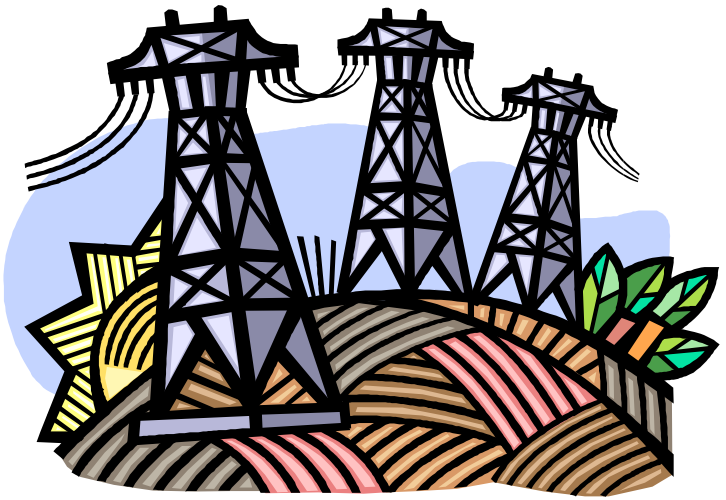
- 1000 gal
- Co-digestion of other materials (green waste, food waste, etc.)

Anaerobic Chamber at USU

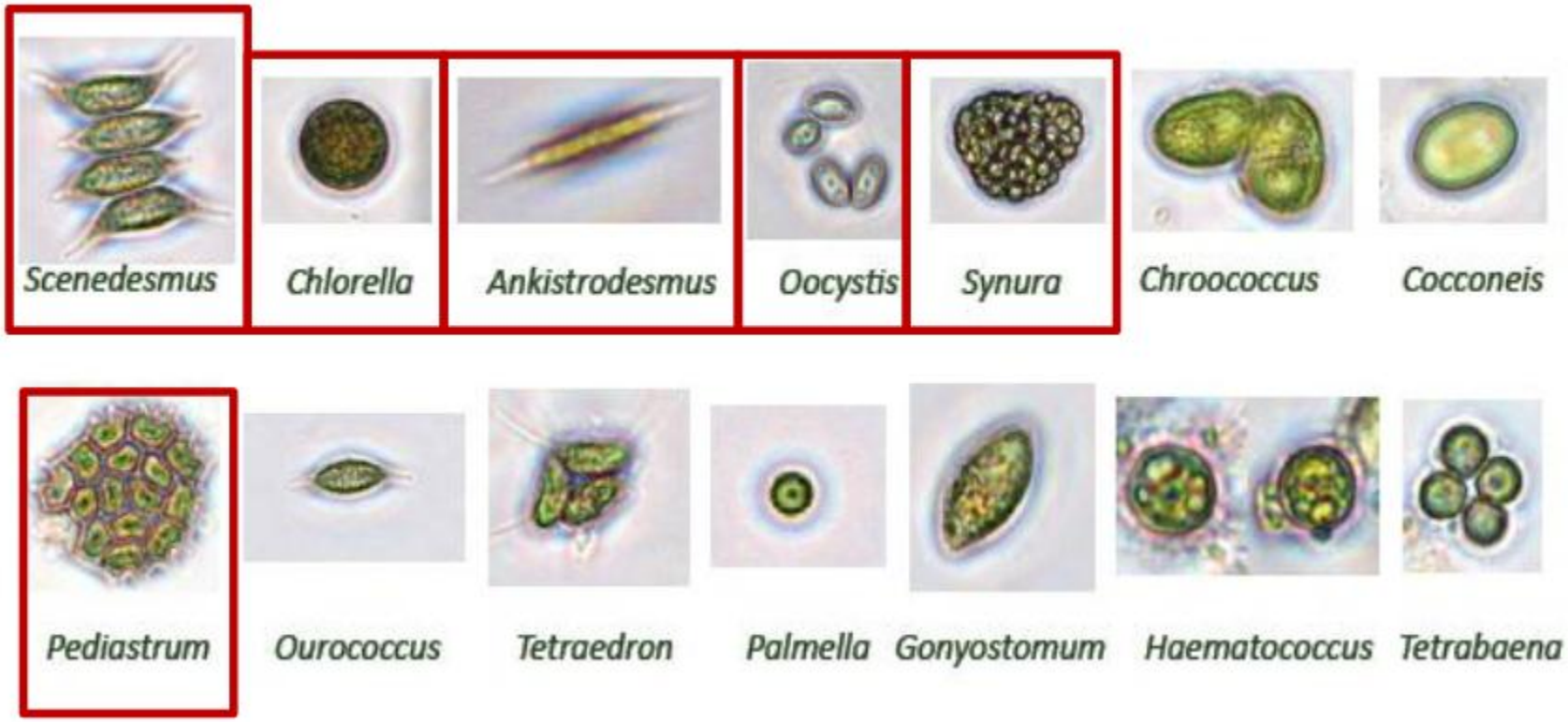
- Identify biogas yields from algae

Estimated Gas Production

- 180,000-500,000 cubic feet per day
- Produce electricity to power 170 – 500 homes



Algae Strains in Wastewater Lagoons

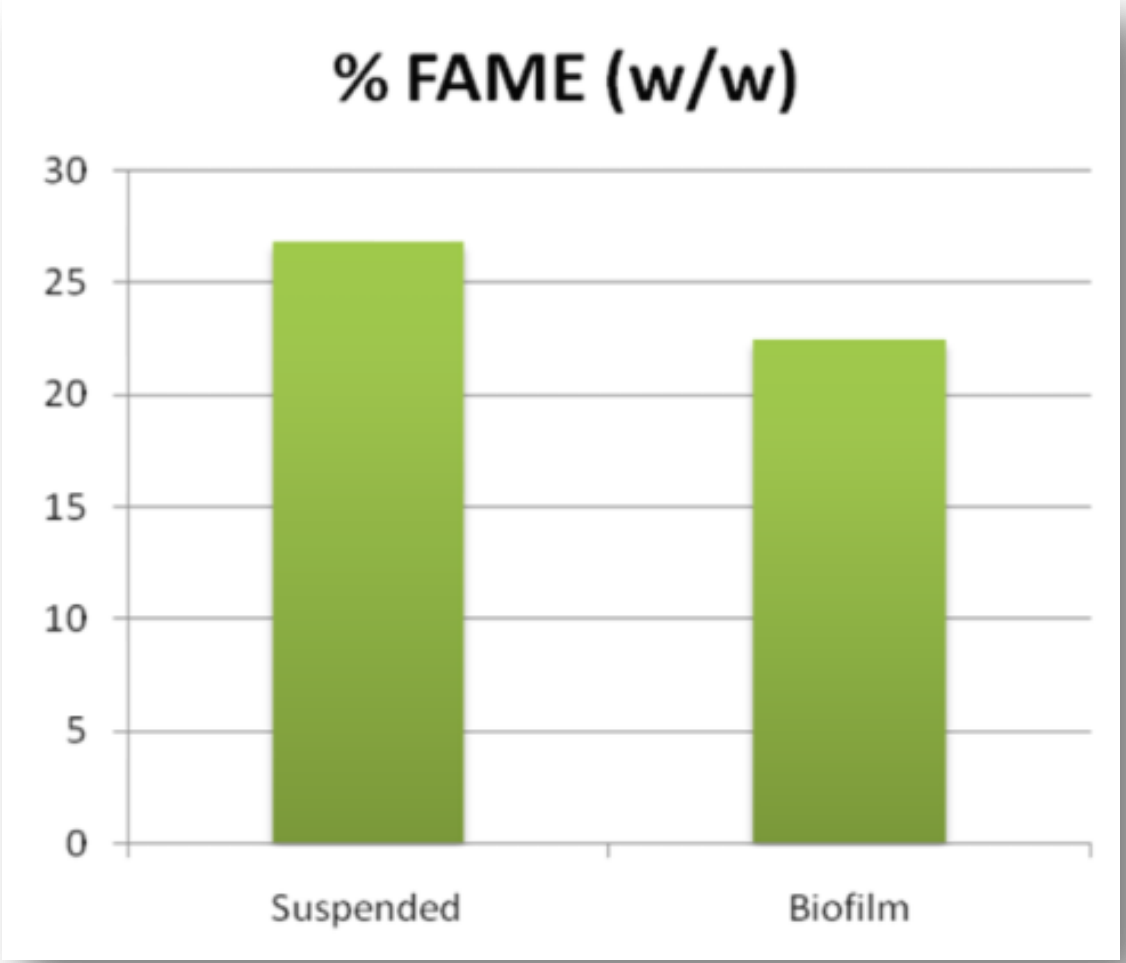


Known to accumulate lipids

Biodiesel

- Conversion of algae lipids to biodiesel
- USU is working on process to produce biodiesel on a large scale

Preliminary Biodiesel Results



Summary

Let nature work for us

- Lower cost
- Better for the environment
- Better for the community

Acknowledgements

http://swbec.usu.edu/

A collaboration between

- USU Biological Engineering Department
- College of Engineering at Utah State University
- Environmental Department, City of Logan, Utah.